FMRI in the Spinal Cord During Bilateral Finger Tapping

J. Van Kylen, P.A. Bandettini, J.S. Hyde
Biophysics Research, Medical College of Wisconsin, Milwaukee, WI

INTRODUCTION:

Functional Magnetic Resonance Imaging (FMRI) of the spinal cord is complicated by technical limitations and physiologic noise. We have used bilateral finger tapping, which is controlled by innervation sites located at the seventh and eighth cervical segments (1-2), to test the feasibility of functional imaging of the spinal cord.

METHODS:

All experiments were performed on a G. E. 1.5T Signa System using the body gradient coil and body radiofrequency coil. Three healthy male volunteers between the ages of 20-30 were studied in a supine position during a paradigm consisting of ten 30 second periods. The periods alternated between a control state and a task activation state. The control state was resting with eyes closed. The task activation state consisted of bilateral finger tapping with eyes closed. A series of one hundred mid-sagittal spiral images were acquired with the following parameters; TR=300msec, TE=30msec, FOV=36cm, slice thickness=10mm, flip angle=45°, interleaves=10, and acquisition matrix size 156x156 (3). Each image in the time series was registered to the first image using an intensity based registration technique. Functional maps were created by cross-correlating the time courses with a phased delay boxcar function and using a threshold=0.5 and a correction for linear baseline drift(4). To identify pixels marked as active from motion correlated with the task, the pixel time courses were averaged over the 5 on periods. Pixels that displayed activation patterns with a greater than 25 percent signal change or did not have a delay of peak activation of at least six seconds from the beginning of the task were eliminated.

RESULTS:

Activation sites within the spinal cord near the seventh and eighth cervical segments were seen in two out of the three subjects after all activation criteria had been applied. Figure 1 displays a typical spiral image. Figure 2 displays a percent change map. Area 1 is located in the supplementary motor area (SMA), had percent signal changes less than 25 percent, and a delay time of at least six seconds. Area 2 is in the spinal cord, had percent changes less than 25 percent, and a delay time of at least six seconds. Area 3 had signal changes larger than 25 percent and/or delay times of less than six seconds. Figure 3 displays the averaged time courses from the SMA and spinal cord from the same volunteer.

CONCLUSION:

Using a finger tapping task we have shown functional activation in the spinal cord that remains after image registration and the application of activation criteria. While FMRI of the spinal cord has been demonstrated, further studies needed to determine the reproducibility and range of tasks of functional spinal cord imaging.

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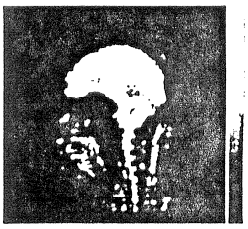

Figure1. A typical spiral image

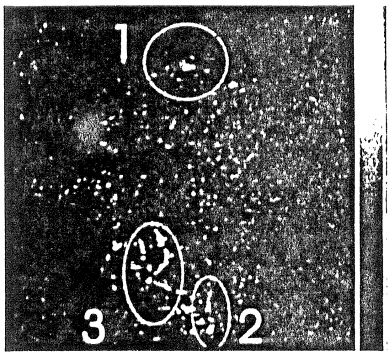

Figure 2. Percent change map

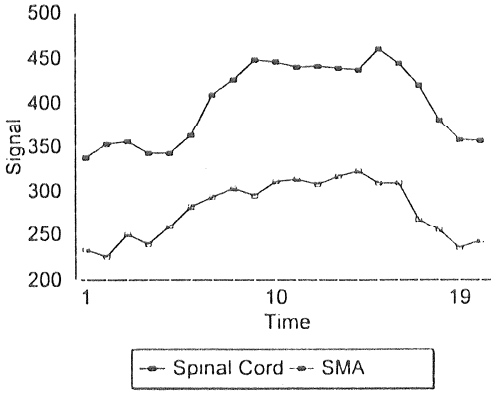

Figure 3. Averaged time course from active pixels in supplementary motor and spinal cord.

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Name Joel Van Kylen
Address Biophysics Research Institute
Medical College of Wisconsin
8701 W. Watertown Plank Rd
City Milwaukee, WI 53226, USA
Telephone (414) 456-4000